INSTITUTE AND FACULTY OF ACTUARIES

EXAMINERS' REPORT

September 2017

Subject ST9 – Enterprise Risk Management

Introduction

The Examiners' Report is written by the Principal Examiner with the aim of helping candidates, both those who are sitting the examination for the first time and using past papers as a revision aid and also those who have previously failed the subject.

The Examiners are charged by Council with examining the published syllabus. The Examiners have access to the Core Reading, which is designed to interpret the syllabus, and will generally base questions around it but are not required to examine the content of Core Reading specifically or exclusively.

For numerical questions the Examiners' preferred approach to the solution is reproduced in this report; other valid approaches are given appropriate credit. For essay-style questions, particularly the open-ended questions in the later subjects, the report may contain more points than the Examiners will expect from a solution that scores full marks.

The report is written based on the legislative and regulatory context pertaining to the date that the examination was set. Candidates should take into account the possibility that circumstances may have changed if using these reports for revision.

Luke Hatter
Chair of the Board of Examiners
December 2017

A. General comments on the *aims of this subject and how it is marked*

1. The aim of the Enterprise Risk Management (ERM) subject is to instil in successful candidates the key principles underlying the implementation and application of ERM within an organisation, including governance and process as well as quantitative methods of risk measurement and modelling. The student should gain the ability to apply the knowledge and understanding of ERM practices to any type of organisation.

2. The ST9 exam generally requires bullet point form or short form essay style answers that apply general principles to directly address specific circumstances. The answers given below are just one possible set of acceptable answers.

3. Candidates are awarded marks for all reasonable answers including different but still reasonable numerical solutions. Marks are awarded for working in the case of numerical answers.

4. Candidates' answers are made up of a series of points. For example, a point can be stating a valid type of risk, describing the type of risk or (part of) a calculation.

5. Candidates who give well-reasoned points, not in the marking schedule, are awarded marks for doing so.

B. General comments on *student performance in this diet of the examination*

1. The paper was made up of two medium-length questions and one long question

2. Question 1 covered approaches to risk management frameworks; question 2 covered risk modelling and mitigation; and question 3 covered risk identification economic capital and liquidity risk.

3. As is common practice, the large majority of the questions were:

   - based on bookwork, and/or
   - based on simplified case studies; and/or
   - loosely based on actual and often relatively recent events.

4. The examiners seek to test the candidate's knowledge of the syllabus. The core reading is an important source for framing questions but not the only source. For this reason, candidates are encouraged to read the financial press and to consider how current news items can be applied to the issues and concepts contained in the core reading.

Well-prepared candidates scored well across the whole paper. As is often the case, most of the problems occurred when students failed to cover a wide enough range of points in a question. However, many students in this diet lost marks on relatively straightforward knowledge questions. In many cases, a significant proportion of candidates scored no marks on questions such as these. The comments that follow the questions aim to highlight these instances, and thus concentrate on areas where candidates could have improved their performance.

C. Pass Mark

The Pass Mark for this exam was 58.

Solutions

Q1 (i) The function does not need to be overly large (*alternatively: function can be small)* [½]

or complicated *(alternatively: function structure can be simple)* [½]

One or two people should work directly with the CRO [½]

to help to collate risk information from the business teams [½]

and to draft risk protocols [½]

working closely with the various business teams. [½]

Members of each business team should also have responsibilities to fulfil risk-related responsibilities [½]

but in a first-line context [½]

Should provide advice to line managers [½]

Should report to board [½]

Should have appropriate resources, technical skills [½]

[Max 3]

This question was moderately well-answered, with most candidates scoring at least some marks

(ii) Having a range of sports covered reduces the chances of there being a concentration of risk [½]

for example, if poor weather causes a spate of cycling losses [½]

It may also reduce the seasonality of claims [½]

Diversification between insured risks is increased [½]

Which would use capital more efficiently [½]

The change should increase the volume of business [½]

meaning the risk of insolvency from a large single loss should be reduced [½]

and it will reduce random fluctuation / stochastic risk [½]

ERM may have highlighted total risk was lower than risk appetite encouraging the expansion in strategy? [½]

ERM may have highlighted upside risks in new strategy [½]

[Max 3]

This question was reasonably well-answered

(iii)Having the CRF confined to a single office means that risks in the wider company might be missed

Since they receive data without being embedded in teams, the CRF might not understand the context of the risk information

Similarly, the CRF might not understand the context when drafting risk procedures

Similarly, the CRF might lose touch with the changing business environment

There might also be resentment from business units receiving missives from a "distant" CRF

The relationship between the CRF and business units may be adversarial
poor culture

Communication between the CRF and business units may not be open

It might be more likely that the business units will "hide" problems/risk events/accidental policy violations
Potential problems may only be discovered when it is too late to rectify them effectively

Having the CRO as a part-time role might no longer be appropriate

given the increased complexity of the business

[1 mark per point for the first two valid points, then ½ mark per point]

[Max 4]

Most candidates scored highly on this question

(iv) Use a partnership model [½]

Embed members of the CRF in each team… [½]

and/or in each location [½]

Create a separate CRO role [½]

with a seat on the board [½]

CRF staff to work together with individual teams to draft procedures… [½]

and to resolve risk management issues [½]

Give more decision-making autonomy to individual teams [½]

May wish to design new dedicated risk reports rather than using data taken from the general MI reports [½]

Hire more senior team members/appoint more senior individuals to roles [½]

[Max 3]

This question was reasonably well-answered

(v) Currency risk from non-domestic premiums [½]

or non-domestic claims [½]

Regulatory risk from operating in different insurance regimes [½]

Insurance risk: significantly increased exposure to perils that are not relevant to the domestic country (e.g. natural disasters/weather events) [½]

Pricing risk from lack of experience in relation to these different levels of insurance risk [½]

Investment risk, if appropriate risk-free/matching assets are unavailable [½]

Operational risk from operating in countries with different languages [½]

setting up systems for operating cross border etc. *(any valid examples)* [½]

Increased operational risk if volume of business expands significantly [½]

Potential increase in fraud/moral hazard risk, depending on markets [½]

Market demand risk: uncertainty as to the level of demand for such insurance in other countries [½]

Economic risk: level of demand may be dependent on economic conditions in these overseas countries [½]

Counterparty risk: if local assistance/expertise required in setting up in the overseas countries [½]

Political risk: attitude towards non-domestic insurers may change [½]

Reputational risk: may not have sufficient brand awareness overseas [½]

Strategic risk: management may be stretched too thinly if try to expand too quickly [½]

[Max 5]

Most candidates scored well, giving a good range of risks and descriptions

Q2

(i) **Primary Points**

Market risk: extreme losses in the fund [½]

particularly when both books and records perform poorly, given the lower tail dependence [½]

Expense risk: higher than expected costs of managing the fund [½]

particularly costs in relation to the resources required to secure books/records [½]

Model risk: on construction of optimal portfolio [½]

particularly since it uses a multivariate normal distribution [½]

whose copula has no upper or lower tail dependency [½]

Parameter risk: on the expected future returns [½]

and volatility [½]

since these are likely to be based on the historic figures, which may not be replicated in the future [½]

In particular, strong past returns may be a result of assets becoming overvalued [½]

which would depress future returns [½]

Also, a portfolio optimised on past volatility may simply give a portfolio whose volatility is low due to "luck" [½]

Risk of future returns being depressed by cash balance waiting for investment [½]

Liquidity risk: risk of having insufficient cash/liquidity to meet outflows… [½]

due to time taken to sell books/records [½]

In particular, risk of being unable to get desired price for assets if sale required [½]

Secondary Points

Key man risk [½]

Forgeries [½]

Change in consumer preferences [½]

Finding assets [½]

Regulations (import/export) [½]

(Any other valid risk) [½]

[Max 5, of which max 1 from secondary points]

Most candidates scored reasonably well on this question

(ii) It defines the relationship between two variables (X and Y) [½]

at their lower margin. [½]

Specifically:

$$_L\lambda_{X,Y} = \lim_{q\to 0^+} \Pr[X < F_q^{-1}(x) \,|\, Y < F_q^{-1}(y)] \quad [1]$$

or

$$_L\lambda_{X,Y} = \lim_{q\to 0^+} \frac{C\left(F_q(x), F_q(y)\right)}{q} \quad [1]$$

(fraction of marks for small mistakes)

where $F_q^{-1}(x)$ is the value of x for which the cumulative distribution function $F(x) = q$. [½]

The coefficient lies in the range [0,1] [½]

If it equals 0, there is no lower tail dependence. [½]

The presence of lower tail dependence can help determine which copula is most appropriate to use for a particular dataset. [1]

Tail dependence is importance for risk management as it describes potential concentrations of risk at the point in the distribution where this risk really matters. [1]

[Max 4]

Although most candidates scored some marks on this question, very few scored full marks for what was essentially knowledge

(iii) Clayton (or generalised Clayton) copula could be used [1]

as this has lower tail dependency [1]

This question was well-answered, with many candidates scoring full marks; however, a significant proportion scored no marks at all, despite this being a knowledge question

(iv) Gumbel copula could be used [1]

as this has upper tail dependency [1]

Again, this question was well-answered, with many candidates scoring full marks; but again, a significant proportion scored no marks at all.

(v) Similarities:

They both allow an investor to fix now the price of an asset at some point in the future [½]

They both allow an investor to take either a long or a short position in the asset [½]

Differences:

Futures are exchange traded [½]

whereas forwards are traded over-the-counter [½]

Futures have a high degree of security; counterparty risk is an issue for forwards [1]

Margins are posted for futures [½]

Collateral can be used for forwards (but not always) [½]

Futures are highly standardised contracts; forwards less so and therefore are more flexible [1]

Futures are highly liquid contracts; forwards have less liquidity [1]

[Max 4]

Candidates generally scored well on this question

(vi) Correct that using an index future limits the extent to which short positions can be taken [½]

therefore there is basis risk [½]

Essentially can only short large cap equities [½]

and only in proportion to their weights within the index [1]

As only hold a small number of equities, may well not invest in all of the large cap equities which are covered by the index [½]

Futures on some individual large cap stocks could exist, so these could be used [½]

although likely to be less liquid than index futures [½]

But futures on individual small cap stocks are unlikely to be available [½]

It may not be an issue that the fund would remain net long in small cap equities [½]

The company may also only take views on which specific companies are especially cheap (long positions) rather than those that are especially expensive (short positions) [½]

The fact that futures are liquid is likely to be important for an open-ended fund, where the assets invested can change (up and down) quickly [1]

Potentially forwards could be used in addition to futures [½]

It may be easier to arrange forwards for individual small cap equities [½]

However, it might take time to get an ISDA into place to trade forwards [½]

And forwards tend to have greater counterparty risk than futures [½]

Additional complexity [½]

Frequent rebalancing [½]

Small cap futures may exist [½]

[Max 5]

Many candidates struggled with this question, although very few failed to register any marks.

(vii)Sell a call option [½]

with a strike price above the current share price [½]

Use the proceeds to buy a put option… [½]

with a strike price below the current share price [½]

This question was very poorly answered, with a large number of candidates failing to gain any marks.

(viii)The equity index future is held short [½]

so in this case the "upside" is a fall in equity prices within the index and the "downside" is an increase in equity prices within the index [½]

Therefore need to sell an equity index put option [½]

with a strike price below the current equity index price [½]

Use the proceeds to buy a call option [½]

with a strike price above the current equity index price [½]

[Max 2]

This question was very poorly answered, with most candidates failing to score at all.

Q3

(i) **Interest rate risk**

An increase in interest rates would reduce the value of the bonds held [½]

Interest rate risk also arises from changes in interest rates which have a negative financial impact on the savings accounts/mortgages [½]

This will depend on whether these are offered at fixed or floating rates [1]

Interest rate changes may also impact on customer behaviour [½]

E.g. early repayment of fixed rate mortgages when interest rates fall [½]

Or could impact levels of demand for the products [½]

Additional risk arises due to the duration mismatch between assets (bonds and mortgages) and liabilities (deposits) [1]

[Max 2]

Liquidity risk

There is a risk of not being able to meet cashflow requirements as and when they arise [½]

Or being unable to carry out asset transactions without materially impacting market prices [½]

In particular, Yellow Town Society may not always have sufficient available cash to meet customers' deposit withdrawal requirements [½]

[Max 1]

Credit/counterparty risks

There is a risk of increased credit spreads [½]

reducing the value of Yellow Town Society's corporate bonds [½]

The risk of higher than expected defaults on corporate bonds [½]

The risk of higher than expected defaults on customer mortgages [½]

[Max 2]

Other financial market risks

FX risk arises due to exposure to movements in foreign exchange rates [½]

if overseas bonds are held [½]

Mismatch risk [½]

Property risk (re collateral) [½]

There is a risk of significant falls in property values… [½]

which will increase the credit risk on mortgages [½]

Higher than expected inflation… [½]

will increase the society's expenses [½]

[Max 2]

[Max 5 overall]

This question was generally well-answered, with a number of candidates scoring maximum marks

(ii) Authority limits [½]

Concentration/exposure limits [½]

Limits on credit worthiness / credit ratings [½]

Limits on transaction sizes [½]

Limits on timings of transactions [½]

e.g. maximum in any time period [½]

Limits on single counterparties/issuers [½]

Limits on single industries [½]

Limits on currencies [½]

Government v. corporate bond balance [½]

Due diligence checks to be carried out on each transaction [½]

- Sign-offs/approvals required for each transaction [½]
- Reporting procedures [½]
- Valuation metrics/methodology [½]
- ...and in particular metrics used to measure the extent of matching to liabilities [½]
- Regulatory considerations… [½]
- … and taxation considerations… [½]
- … and keeping pace with any proposed changes [½]
- Liquidity limits [½]
- Duration of bonds [½]
- Where the bonds are traded [½]
- How the bonds are traded [½]
- Extent to which use of credit derivatives is permitted [½]

[Max 7]

This question was moderately well answered, but many candidates failed to think of a broad enough range of points. Almost all scored something, but none scored the maximum

(iii)

- This additional information could be used by the investment managers as part of the corporate bond selection criteria [½]
- As it should be correlated to probability of default [½]
- E.g. only invest in those companies with ERM classified as "excellent" or "strong" *(any sensible example)* [½]
- The Society would not be in a position to perform such detailed assessments itself [½]
- The information in the reports could also help it to improve its own internal ERM [1]

However:

- This only reflects the view of one rating agency. [½]
- It is not available for other types of company. [½]
- The method of assessment and measurement criteria are not transparent. [½]
- There is model risk relating to the models used by S&P. [½]
- Risk management is already considered within credit ratings. [1]
- The assessment may not be complete. [½]

[Max 4]

This question was moderately well answered

(iv)

- For each asset position held, it could calculate the time that it would take (in days) to liquidate that position under adverse market conditions [1]

- It could calculate the ratio of liquid assets to total assets [1]
- It could compare this to other companies [½]
- Or to a benchmark proportion [½]

- It could use cashflow models [½]
- Which project both asset cashflows and liability cashflows [½]
- Over a chosen time horizon [½]
- To gain an understanding of the timing... [½]
- … and certainty of cashflows [½]
- E.g. may measure by duration mismatch [½]

- Could stress test company-specific events... [½]
- Like a run on the Society's deposits *(any relevant example)* [½]
- And market-wide events [½]
- Like a fall in interest rates *(or any relevant example)* [½]
- Could perform scenario tests [½]
- Which allow for multiple conditions to occur simultaneously [½]
- Model "worst case" scenarios [½]
- Like a recession / serious contraction of bank lending (or any relevant example) [½]
- With mortgage defaults and lower savings and bond defaults and spread widening etc. *(any relevant combination of events)* [½]
- Consider scenarios based on historical events [½]
- Consider scenarios that may occur in the future (potential black swans [½]
- May need expert input to set appropriate stress/scenario tests [½]
- And external data [½]

- The stress/scenario tests need to model the ability to sell assets… [1]
- … and the price at which such assets may be realised… [1]
- … and the ability to raise capital under the chosen conditions [1]

- Such tests can also measure the capital required to restore the position [½]
- Or can use metrics like VaR [½]
- With a chosen confidence interval (or alternatively, determine the confidence level at which expect to (just) have sufficient liquidity) [½]

- Allow for correlations with other risks [½]
- E.g. interest rate risk [½]

[Max 8]

This question was moderately well answered, but again candidates struggled to give a broad enough range of points to score well

(v)

- Cash is normally liquid… [½]
- … so this does increase liquidity [½]
- However, likely to earn a lower return than other assets [½]

- This reduces profitability [½]
- No shareholders, so no adverse impact on share price… [½]
- …but Society members would see higher mortgage rates [½]
- And lower savings rates [½]
- So the Society would be less competitive [½]
- There would be trading costs incurred in changing the current portfolio [½]
- Could issue debt to raise the required cash [½]
- There is an opportunity cost of holding cash in reserve [½]
- Can't invest in other projects [½]
- 40% cash may be too much [½]
- ...or too little to mitigate the liquidity risk [½]
- More difficult to lend [½]
- Counterparty risk if cash with a bank [½]
- Lower capital requirement from holding cash [½]
- Might not be easy to increase to that cash allocation in a short time horizon [½]
- …depending on current asset allocation [½]
- The impact will depend on cash holdings of competitors [½]

[Max 3]

Most candidates scored reasonably well on this question

(vi)

- Improve asset-liability matching [½]
- Particularly for short-term durations [½]

- Increase notice periods on savings accounts [½]
- Limit daily cash withdrawals [½]

- Invest in other types of liquid asset [½]
- e.g. government bonds from high-rated governments [½]
- listed on stock exchanges rather than emerging market government bonds [½]
- Similarly high-rated corporate bonds listed on stock exchange rather than unrated [½]

- Use sources of emergency funding [½]
- Contingency arrangements with other institutions / emergency overdraft facilities [½]
- Insurance arrangements [½]
- Implement active liquidity monitoring/management processes [½]
- Actively manage creditor/debtor balances [½]
- *No marks given for any points about "monitoring"*

[Max 4]

Most candidates scored reasonably well on this question

(vii)

- The board intends to consider risk in its decision-making [1]
- This is appropriate as decisions should not be made on the basis of profit alone [½]
- Risk appetite is the targets and limits for risk across the whole organisation [½]
- These may be broken down into more detailed risk tolerances [½]
- The board can compare the risks arising with the risk appetite [1]
- Risk profile is the complete description of the organisation risk exposures [½]
- The board can look at the change in the risk profile [½]
- Economic capital is the amount of capital required to ensure a given level of solvency of an organisation at a given confidence level [1]
- It may be consistent with the solvency target set by the regulator [½]
- Or the board may wish to target a specific credit rating [½]
- The board will be able to see whether it has sufficient available capital [½]
- Or whether it would need to raise additional capital [½]
- Or implement additional risk mitigation activities [½]
- The results of these comparisons/assessments may automatically reject an options [½]
- The economic capital requirement information will help to assess a risk-adjusted return on capital [½]

[Max 6]

Candidates scored moderately well on this question

(viii)

- Actions which the company could take at future points in time in response to particular scenarios within the model… [1]
- … such as investment performance outcomes… [½]
- … or solvency / available capital levels… [½]
- … or new business volume levels. [½]

Most candidates scored around half of the marks available here, but a significant proportion scored no marks at all

(ix)

- Changes to investment strategy [½]
- Capital raising [½]
- Limits on new business volumes [½]
- Withdrawal of particular products (or change in balance of business sold) [½]
- Introduction of new products [½]
- Level of risk mitigation techniques in place [½]
- E.g. levels of reinsurance used [½]
- Interest rates charged on mortgages [½]
- Interest rates offered to deposits [½]
- Premium rates charged on insurance [½]
- Any bonuses offered to Society members [½]
- Changing lock-in time for deposits [½]

- Charging for services [½]

[Max 4]

Most candidates struggled with this question, with most only making two or three valid points, and many making none.

(x)

- RAROC is calculated as (expected) risk-adjusted return / economic capital [1]
- The measure is risk-adjusted so allows for the riskiness of each strategy [1]
- And avoids being able to increase the return on capital by reducing the amount of capital held [½]
- The measure allows for the capital required to support the strategy [½]
- So is particularly useful when capital is scarce [½]
- As it may be here, given that this is a mutual society [½]
- This measure assumes that the amount of capital required to support the strategy is proportional to riskiness of the strategy [½]
- This is appropriate when the response to the risk is to hold capital… [½]
- … but not so good for operational risks [½]
- Can compare strategies to each other, so suitable for this purpose, [½]
- Or to a target level (hurdle rate) [½]
- May be difficult to determine consistent risk-adjustments for the risk-adjusted return figure [½]
- Particularly as the strategies have different inherent levels of risk [½]
- The metric does not capture the quantity of return [½]
- RAROC may be difficult to explain relative to existing approaches [½]

[Max 5]

Many candidates struggled to come up with a broad enough range of points here. No-one scored the maximum available, and a number failed to gain any marks

(xi)

- Economic Income Created EIC [1]
- Member value [1]
- Member value added [1]

[Max 2]

[Note: there are no shareholders as this is a mutual, but "shareholder value (added)" is an acceptable alternative wording for the second and third metrics.]

Many scored full marks here, but a large number scored no marks at all, instead focussing on metrics that were not related to economic capital

(xii) *Two of the following, to relate to the two chosen for the previous question part:*

Economic income created EIC:

- Risk adjusted return – (hurdle rate × economic capital) [OR (Risk-adjusted return – hurdle rate) × economic capital] [1]
- Measures how much return is generated [1]
- Options with marginal return on economic capital greater than the hurdle rate could be considered [1]

Member value:

- Present value of all future cashflows [1]
- Economic capital × (risk adj return on capital – growth)/(hurdle rate – growth) [1]
- Makes allowance for the term of the cashflows /measures performance over a given (longer) period of time [1]

Member value added:

- Present value of all future cashflows in excess of the economic capital consumed [1]
- Economic capital × [(risk adj return on capital – growth)/(hurdle rate – growth) – 1] [1]
- Makes allowance for the term of the cashflows / measures performance over a given (longer) period of time [1]

[Max 3 marks for each metric]
[Overall max 6]

Almost half of all candidates failed to score on this question.

END OF EXAMINERS' REPORT